Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Partner’s Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Are You an Astronaut?**

**Introduction:** NASA wants nothing but the best of the best to perform missions in space. To be the best you must have blood pressure and lung capacities within normal ranges. When blood pressure gets too high you develop an increased risk of heart disease, blindness, and heart attacks. When lung capacities are too low a person may experience shortness of breath and will not be able to perform physical tasks as well as someone who has higher lung capacities. You can see why NASA would not want to spend millions of dollars sending a person into space if they are at risk for these problems. For this lab you will test your blood pressure, resting heart rate, and lung capacities to see if you are eligible to become an astronaut. NASA will not allow anyone with below average performance to be sent into space because of your personal safety. People who are not eligible to become astronauts are still needed as ground crew. These are also highly paid jobs and require high sets of mental skills.

**Your Task:** Work in partners of two. Blood pressure is nearly impossible to measure by yourself using the stethoscope-sphygmomanometer traditional method. Your job will be to measure your partner’s blood pressure and your partner will measure yours. You will also be measuring your own lung capacity and comparing that and your blood pressure measurements to averages to determine if you are eligible to become an astronaut.

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**Disclaimer: Mr. Herbst is not a doctor. Therefore, I cannot and/or will not access your physical health or tell you that you are at risk for certain diseases. These questions are to be discussed with your family physician if there are concerns. Please sign below if you understand these guidelines:**

**Signature\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Part 1: Blood Pressure**

Systolic BP: The pressure (measured in mm Hg) inside the arteries during ventricular contractions.

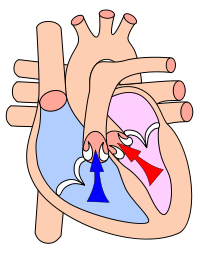
Diastolic BP: The pressure (measured in mm Hg) inside the arteries during relaxation of the heart muscle.

<100 / 60: low blood pressure (hypotension)

120 / 80: average human blood pressure (normal)

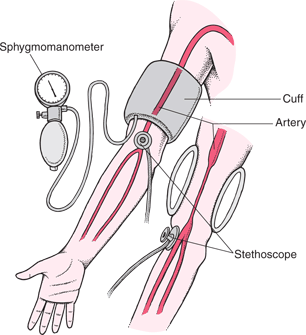
120-140 / 80-90: high blood pressure (pre-hypertension or BP during exercise)

>140 / 90: very high blood pressure (hypertension and usually requires medication)



Carries blood to the lungs (cannot be measured)

Carries blood to the body (can be measured)



**Part 1 (cont.):**

1. Put the stethoscope into your ears and use the flat end of it to locate your partner’s brachial artery. This artery runs the length of your arm and passes right over the inside of the elbow as shown in the image above. If you have properly located it you should hear a continuous “thump” sound. This is your pulse. In some people this artery is easier to find than others so don’t get discouraged if you cannot hear it right now. Do not spend too much time on this and continue to the next step if you cannot locate it.

2. Put the sphygmomanometer (a.k.a the arm cuff) on your partner. Make sure the air tubes leaving the arm cuff are in line with the brachial artery.

3. Carefully inflate the arm cuff to 180 mmHg. If you partner is experiencing discomfort then inflate the arm cuff to only 150 mmHg. The brachial artery should be sealed off (closed) due to the pressure on the artery from the arm cuff.

4. Place the stethoscope over the inside of the elbow and begin to SLOWLY deflate the arm cuff.

5. When you hear a continuous “thump” sound note the pressure reading from the sphygmomanometer. This is your partner’s SYSTOLIC blood pressure. This is the pressure required to open the brachial artery during ventricular contraction. You may also notice the needle on the sphygmomanometer sort of “jump” when this number is reached.

6. Continue to let air out of the cuff until you can no longer hear a “thump” sound. This is your partner’s DIASTOLIC blood pressure. Note the number reading on the sphygmomanometer when you can no longer hear the sound.

7. Practice taking blood pressure readings until you are comfortable with how it works.

8. Now you put on the arm cuff and have your partner wear the stethoscope to practice taking blood pressure readings.

9. When both you and your partner can measure blood pressure with no error perform 3 trials and record the numbers you find below. Record these numbers under “resting blood pressure.”

10. Now perform the same procedure after some light exercise. You can run back and forth through the hallway or just simply do some jumping jacks in place. Whichever ways you decide to exercise do it for at least 3 minutes.

11. When you are done exercising have your partner measure your blood pressure for 3 trials. Record these numbers under “post exercise” in the table below.

12. Now have your partner exercise and you perform 3 blood pressure measurements on your partner.

13. When the trials are all completed calculate the blood pressure means.

**Table 1**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Trial** | **Resting Sys.(mmHg)** | **Resting Dia. (mmHg)** | **Post Exercise Sys.(mmHg)** | **Post Exercise Dia.(mmHg)** |
| **1** |  |  |  |  |
| **2** |  |  |  |  |
| **3** |  |  |  |  |
| **Mean** |  |  |  |  |

**Part 2: Resting Heart Rate**

-NASA also wants to make sure that after you are under stress your body can return back to normal quickly. After exercise, your heart rate should return to it’s resting rate in a matter of a few minutes. A normal resting heart rate is between 50 and 100 beats per minute (bpm.) A lower number usually indicates that your heart can pump more volume of blood per pump and thus does not require as many beats per minute to circulate blood around the body. Lance Armstrong had a resting heart rate of only 33 bpm at the peak of his career.

1. Locate the common carotid artery on yourself. This is the artery located running through your neck and is usually felt best using two fingers.

2. Count the number of times your heart beats in 1 minute and record that number in table 2. Perform 2 more trials.

**Part 2 (cont.)**

**Table 2**

|  |  |
| --- | --- |
| **Trial** | **Heart Rate (bpm)** |
| **1** |  |
| **2** |  |
| **3** |  |
| **Mean** |  |

**Part 3: Lung Capacity**

**-**NASA only selects astronauts who will have the lung capacity needed to perform strenuous tasks out in space. A higher lung capacity is associated with a higher rate of O2 and CO2 gas exchange. Lung capacities are measured in mL (milliliters.) An average total lung capacity for a male is 6000ml and for women is 4200ml. These numbers can change based on your height, age, and smoking status (smoking cigarettes lowers your lung capacity.) Lung capacities are measured on a device call a **spirometer.** Asthma and chronic obstructive pulmonary disorder (COPD) can also lower your lung capacity.

Inspiratory Capacity (IC): This is the total volume of air you can inhale after exhaling to a normal, comfortable level.

Inspiratory Reserve Volume (IRV): After inhaling to a normal, comfortable level this is volume of air you can force into your lungs upon inhalation. IRV = IC - TV

Tidal Volume (TV): The volume of air inhaled and exhaled during a normal comfortable breath.

Expiratory Reserve Volume (ERV): The volume of air that can be exhaled after a normal, comfortable breath.

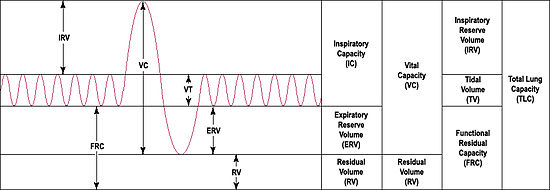
Functional Residual Capacity (FRC): The volume of air left in the lungs after a normal, comfortable breath out. FRC = RV + ERV

Residual Volume (RV): The volume of air still left in your lungs after you exhale as much as you can. This volume cannot be measured using the spirometer so we will assume **1200ml for males** and **1100ml for females.**

Vital Capacity (VC): The total amount of air that can be inhaled and exhaled. VC = IRV + TV + ERV

Total Lung Capacity (TLC); The total volume of air your lungs can possibly hold. TLC = IRV + TV + ERV + RV

**Part 3 (cont.)**



1. Use the alcohol wipes to wipe down the mouthpiece of the spirometer after you use it.

2. **NEVER INHALE WITH YOUR MOUTH OVER THE SPIROMETER!**

3. Take a large, deep breath in as much as possible. While blowing into the mouthpiece, exhale to a normal, comfortable level (the same level as if you were breathing in and out regularly.) This is your **Inspiratory Capacity (IC.)** Record this number in table 3 and complete 2 more trials.

4. Inhale to a normal, comfortable level. Next, exhale into the spirometer to a normal, comfortable level. This is your **Tidal Volume (TV.)** Record this number in table 3 and complete 2 more trials.

5. Exhale to a normal comfortable level. Next, exhale into the spirometer until you can no longer exhale any amount of air at all. This is your **Expiratory Reserve Volume (ERV.)** Record this number in table 3 and perform 2 more trials.

6. Finally, inhale as much as possible. Next, exhale into the spirometer until you can no longer exhale at all. This is your **Vital Capacity (VC.)** Record this number in table 3 and perform 2 more trials. **Note: Inhaling and exhaling this much air too quickly can cause you to be light headed and even pass out. Be sure to give yourself enough time between each trial to avoid passing out!**

7. After all trials are completed calculate the means and record these numbers in table 3.

**Table 3**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Trial** | **IC (mL)** | **TV (mL)** | **ERV (mL)** | **VC (mL)** |
| **1** |  |  |  |  |
| **2** |  |  |  |  |
| **3** |  |  |  |  |
| **Mean** |  |  |  |  |

**Part 4: Calculations and Graphs**:

1. Use the graph paper provided to create a bar graph showing mean systolic blood pressure before and after exercise as well as mean diastolic blood pressure before and after exercise. Hint: Pressure in mmHg should go on the Y axis and your graph should contain 4 bars total.

2. Calculate your Inspiratory Reserve Volume. Be sure to remember your units and show work!

3. Calculate your Functional Residual Capacity.

4. Calculate your Total Lung Capacity.

**Part 5: Follow-Up Questions**

1. What did you observe about the change in your blood pressure readings after exercise? Use specific numbers and details in your answer.

2. NASA will only allow people who have resting blood pressure readings below 120mmHg / 80mmHg and post-exercise diastolic readings cannot be any greater than 5mmHg higher than resting diastolic readings. Did you pass NASA’s test, yes or no?

3. You must have a resting heart rate between 50 and 100 beats per minute to have NASA send you into space. Did you pass NASA’s test, yes or no?

4. Look at the Vital Capacity Averages chart in the front of the room. What is the average Vital Capacity (in mL) for a person of your age and height? How does this compare to your measured Vital Capacity (use your computed average.)

5. NASA will only send those with average or greater than average Vital Capacities into space. Did you pass NASA’s third test, yes or no?

6. Did you pass all of NASA’s physical exams? If so, congratulations you are eligible to be sent into space! If not, do not get discouraged as your brain is still needed to run the ground crew!

7. Most doctors agree that your diastolic blood pressure is more important to have within normal ranges. Can you think of any reasons why this is true?

8. Think of when you water your mother’s flowers in the summer using the water hose. If there is no water pressure no water comes out of the hose. What do you think can happen when blood pressure is too low?